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Conversion of DDT to DDE by two mite species

BY

J. L. AUCAMP * and J. W. BUTCHER (1)

Department of Entomology, Michigan State University
East Lansing, Michigan 48823

INTRODUCTION

BUTCHER, KIRKNEL and ZABIK (1969) demonstrated the ability of *Folsomia candida* (Willem) to degrade DDT in laboratory cultures. Their findings bear an interesting relationship to those of EDWARDS and JEFFS (1964) and SCOPES and LICHTENSTEIN (1967) who observed in their studies on the Collembola an extraordinarily high degree of resistance to DDT by these animals. These studies raised questions about the ability of other microarthropods to convert DDT in the soil. Furthermore, AUCAMP (1968) found that agricultural soils subjected to heavy pesticide spraying programs supported an abnormally high population of astigmatid mites, mainly of the genera *Caloglyphus* and *Tyrophagus*. Populations of other mites were also conspicuously altered, both in terms of species diversity and in total numbers. These preliminary findings led to the laboratory experiments described here, which were designed to further explore the role of microarthropods in soil decontamination.

MATERIALS AND METHODS

Stock Cultures

Two mite species, *Caloglyphus krameri* (Berlese, 1881) and *Rhizoglyphus robini* (Claparède, 1869), were employed in this study. Both species were obtained from soil samples taken on the campus of Michigan State University during January

* On leave from the Department of Zoology, Potchefstroom University for C.H.E., Potchefstroom, Rep. of S. Africa.

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1970. A Tullgren funnel was used for the extraction of the mites, which were collected in a glass jar containing a moistened plaster-charcoal substrate base. The mites were removed at regular intervals and placed in small plastic containers containing plaster-charcoal substrates. Powdered brewers yeast was furnished for nutrition. All recovered individuals of both species were in the hypopus stage. Development, however, was rapidly resumed after transfer to the plastic jars which contained a high humidity, ample food and optimum temperature. Single-species stock cultures were established by transferring single gravid females to stock-culture rearing chambers, constructed as follows: A 1:1 mixture of plaster of Paris and powdered activated charcoal in water was poured into a plastic container 8 cm high and 11 cm in diameter, filling the container to within one cm from the top. A 4 cm piece of polystyrene tubing with a diameter of 5 cm was inserted 1 cm deep into the still fluid plaster-charchoal. After the plaster-charcoal hardened, the open end of the tube was capped by a lid with a three cm aperture, which was covered with a 400 mesh (31 microns) nylon gauze. The mites were reared in the tubing using yeast as food. With this system water could be added to the substrate from the outside without disturbing the mites, and the ventilation obtained through the large-sized aperture in the lid prevented excessive condensation inside the chambers. The chambers were kept on open shelves in the laboratory where temperatures varied between 24° C and 30° C. This method allowed us to maintain healthy single-species cultures containing a few thousand mites each. When detritus accumulation in the chamber became excessive, the contents were washed in water and strained through a large mesh nylon gauze filter. All of the adult mites and most of the immatures were retained on the filter, while the small particles of detritus were flushed away. The filter was drained of surplus water on filterpaper, after which the mites were transferred to a freshly prepared rearing chamber.

Exposure to DDT

The mites were exposed for 24 hours to yeast containing pp' DDT at 1000 ppm concentration. This was done as follows: The mites of a particular stock culture were deprived of food for 24 hours. This provided a large number of relatively clean mites, which could easily be transferred to a smaller vessel. Again, in this vessel the relative humidity was maintained at a high level by means of a layer of moist plaster-charcoal. An ample quantity of yeast with DDT was added, and the vessel was covered and incubated at 22° C for 24 hours. To prepare the yeast, known quantities of pp' DDT were dissoleved in hexane. This DDT solution was thoroughly mixed with the yeast after which the hexane was completely evaporated.

Recovery of the Mites

After 24 hours had elapsed the contents of the exposure vessel were emptied into a glass beaker and allowed to soak for three minutes This mite-yeast-water mixture was poured into a separation funnel to which a small quantity of hexane was then added. After being gently shaken for 30 seconds, the mites were taken up in the hexane where they could be seen at the hexane-water interface. The water containing yeast residues and detritus was drained, and clean water was added. This process was repeated until all detritus was fully removed. Following this, the hexane was drained from the mites which were then collected

on a piece of nylon gauze where they were given a quick rinse in clean hexane to remove any external traces of DDT. The rinsed mites were then dried for five minutes under vacuum and weighed on a Cahn electrobalance. The fact that the mites were still alive after this treatment served as an indication that the hexane failed to penetrate their bodies. This led to an assumption that the separation processes had not significantly altered the body content of DDT or any of its metabolites.

Gas Chromatograph Analyses

Pre-weighed quantities of DDT exposed mites were introduced into a seven cc glass tissue grinder where they were macerated in hexane After a thorough maceration and mixing in the tissue grinder, the hexane was decanted and saved for injection into a gas chromatograph. An aerograph gas chromatograph equipped with discharge electron capture detector was used for the analyses. It was fitted with a column packed with 11 % QF-1 3 % DC on 60/80 mesh gas-chrom Q. Nitrogen served as the carrier gas. Standards were injected at the beginning and at the end of each run. Quantitations were based on peak area and concentrations were based on the live weight of the mites analyzed.

Controls

Mites of both species which had not been exposed to DDT containing yeast were extracted in the same manner and served as controls. The experiment was conducted with two replicates of each species.

RESULTS

Gas chromatograph recordings of the analyses of DDT and metabolites in the two mite species respectively showed that *R. robini* was capable of only a limited degree of conversion of DDT to DDE. After the 24-hour period, the bodies of these mites contained 38 ppm DDT. A trace of DDE $<.01$ ppm could be detected. *C. krameri,* on the other hand, was extraordinarily successful in converting DDT to DDE. After the 24 hours elapsed, only a trace of DDT $<.01$ ppm was present in their bodies, but the DDE concentration reached 30 ppm. Both replicates of each species yielded the same results. These findings were further substantiated by numerous exploratory experiments.

DISCUSSION AND CONCLUSION

The possibility exists that the strain of *C. krameri* used in this experiment possessed an acquired rather than a natural resistance to DDT. These mites were collected on the university campus which has a long history of DDT spraying. The stock cultures were derived from a small number of collected individuals, which probably represented the same population. However, the

fact that these mites are known to be extremely resistant to a wide variety of pesticides besides DDT gives rise to the suspicion that the ability to metabolize DDT is a naturally occuring phenomenon. More extensive sampling admittedly, will be necessary to illuminate this aspect of the problem. The striking difference between *C. krameri* and *R. robini* in respect to this phenomenon again emphasizes the major physiological differences which can exist between morphologically similar organisms.

The authors aknowledge that the extraction of DDT and metabolites from the bodies of the mites through maceration in hexane may fail to recover all the pesticides present in the mites. Repeated tests, however, have indicated that this method consistently yields comparable and reproducible results.

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Abstract

This study demonstrated that *C. krameri* is capable of rapidly converting to DDE the DDT entering the digestive tract with contaminated food. *R. robini*, collected from the same habitat, is poorly adapted for this function and yields only minute quantities of DDE.

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